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Lee et al.

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(54) **AIR CONDITIONER AND CONTROL METHOD THEREOF**

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F25D 29/00 (2006.01)
F25B 49/02 (2006.01)
F25B 13/00 (2006.01)

(52) **U.S. Cl.**

CPC ***F25D 29/00*** (2013.01); ***F25B 49/02*** (2013.01); *F25B 13/00* (2013.01); *F25B 2313/007* (2013.01); *F25B 2313/0231* (2013.01); *F25B 2600/07* (2013.01)

(58) **Field of Classification Search**

CPC F24F 13/20; F24F 1/02; F24F 1/0007; F25D 3/122
USPC 62/56, 126, 228.1, 259.1
See application file for complete search history.

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(57) **ABSTRACT**

An air conditioner is provided. The air conditioner includes at least one outdoor unit, a plurality of indoor units, and at least one remote controller to receive operation commands for the plural indoor units. One of the plural indoor units may be selected as a power-supplying indoor unit to supply electric power to the at least one remote controller, based on voltage values of electric power to be supplied from the plural indoor units to the at least one remote controller. The selected indoor unit supplies electric power to the at least one controller. The air conditioner enables a supply of electric power with a sufficiently high voltage to a remote controller by supplying electric power to the remote controller by one indoor unit exhibiting a highest voltage value of electric power to be supplied to the remote controller, as compared to other indoor units.

19 Claims, 16 Drawing Sheets

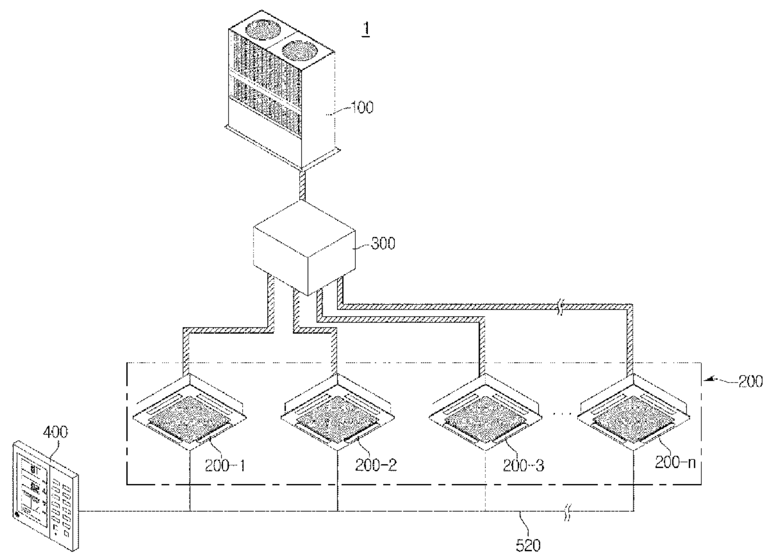


FIG. 1

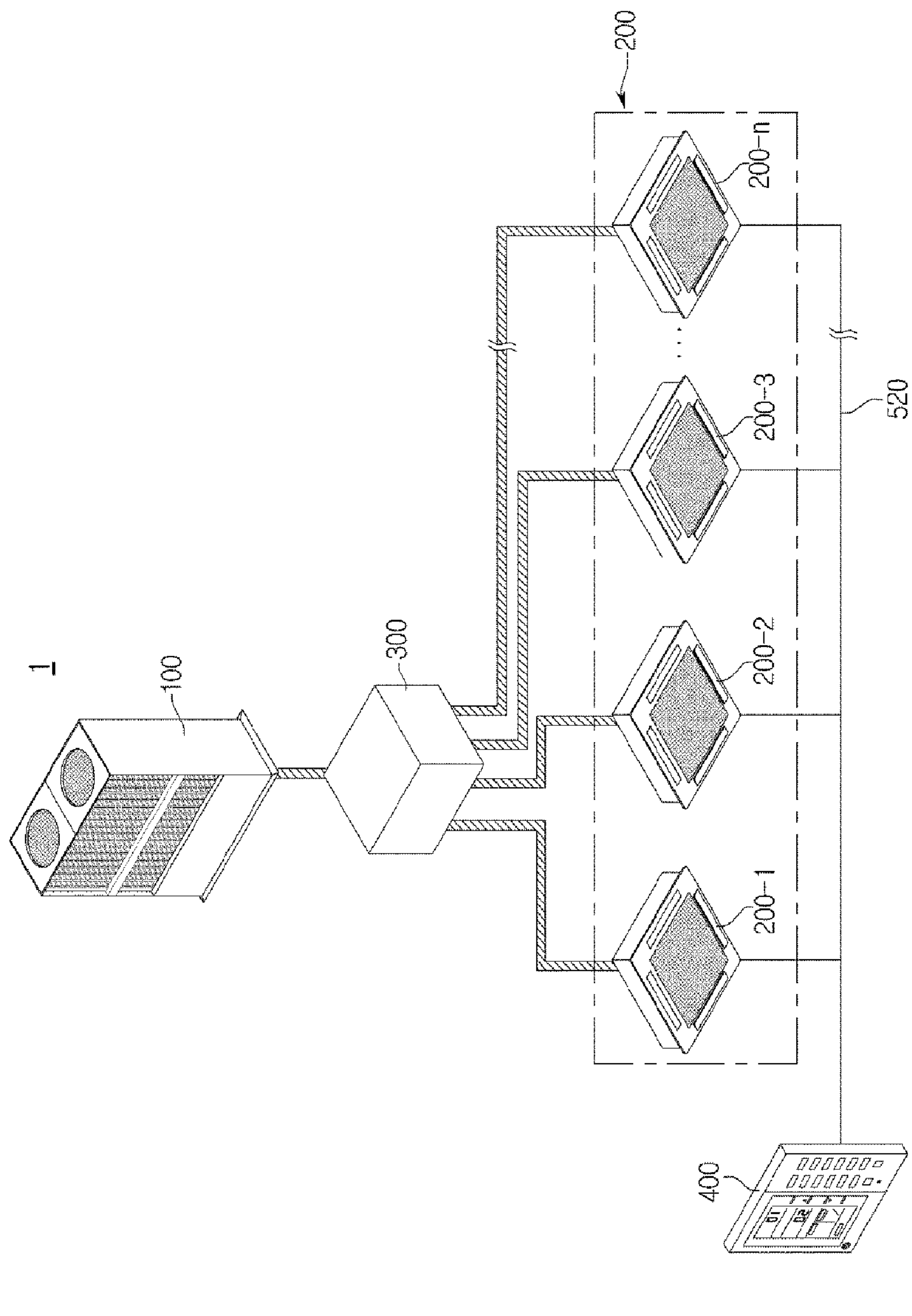


FIG. 2

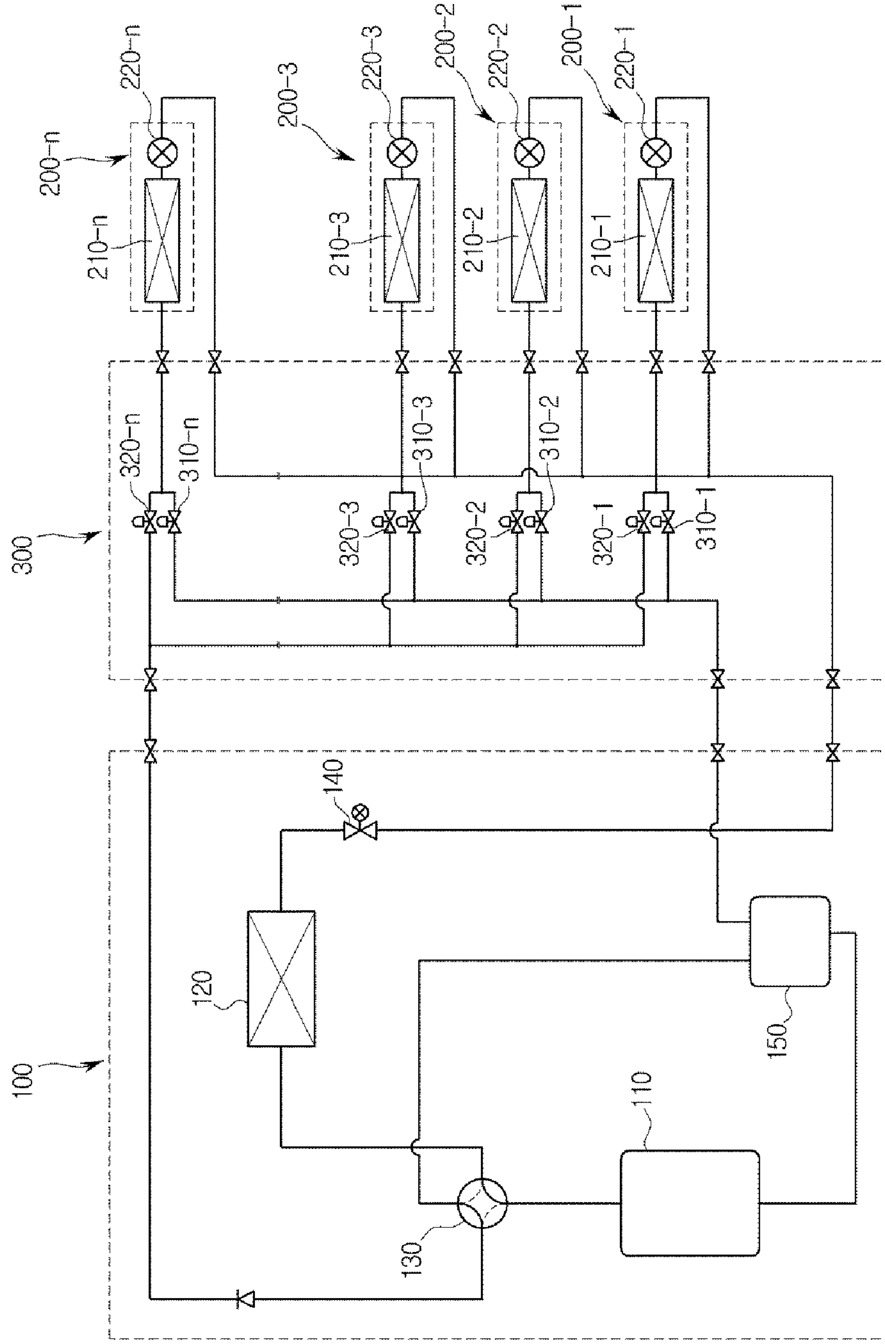

200-n
220-n
210-n
200-3
220-3
210-3
200-2
220-2
210-2
200-1
220-1
210-1
300
320-n
310-n
320-3
310-3
320-2
310-2
320-1
310-1
100
140
120
150
110
130

FIG. 3

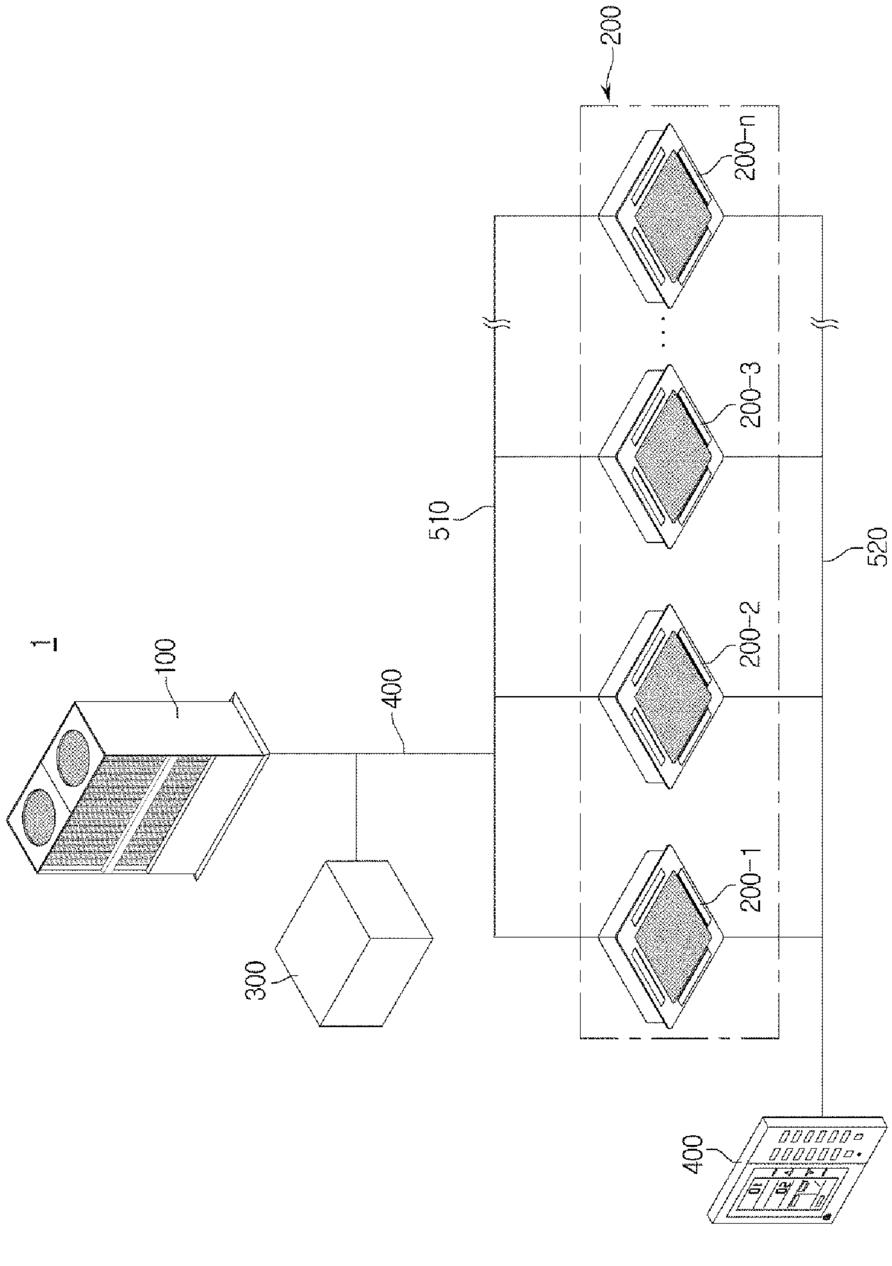


FIG. 4

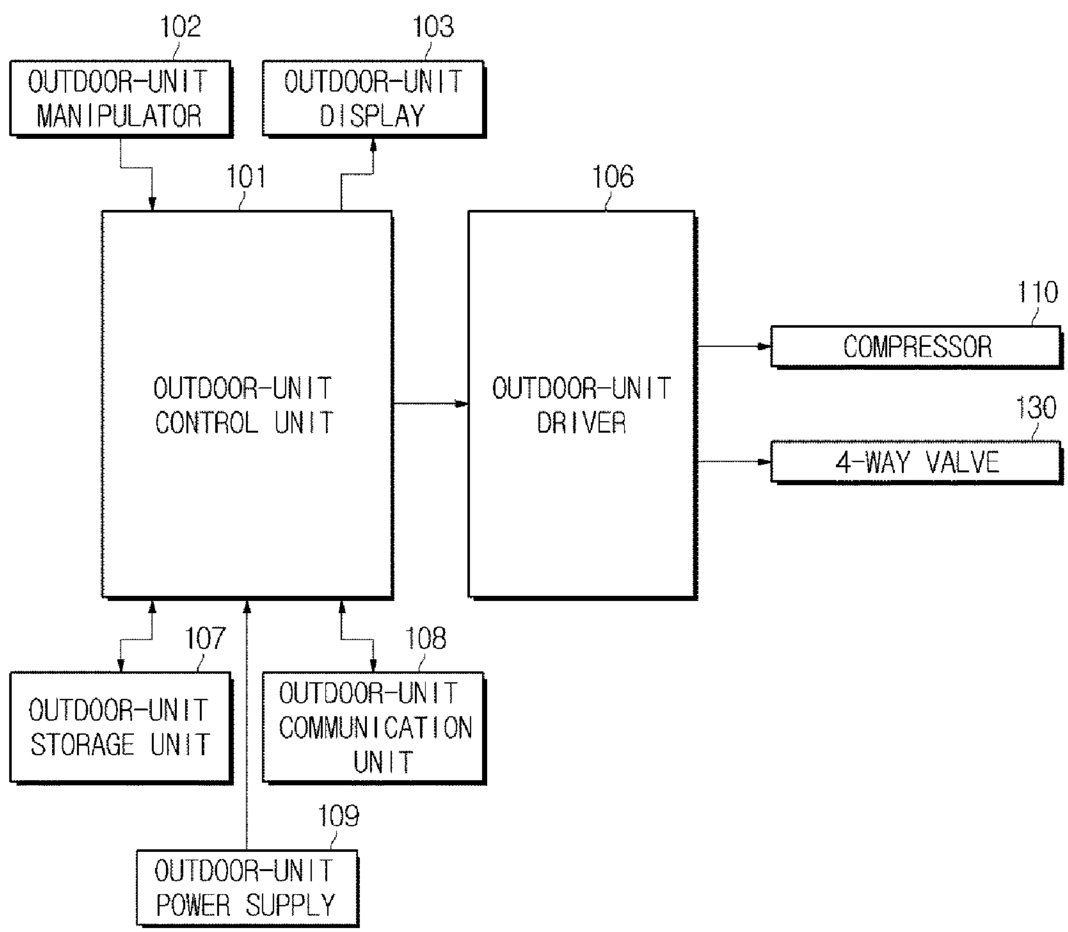
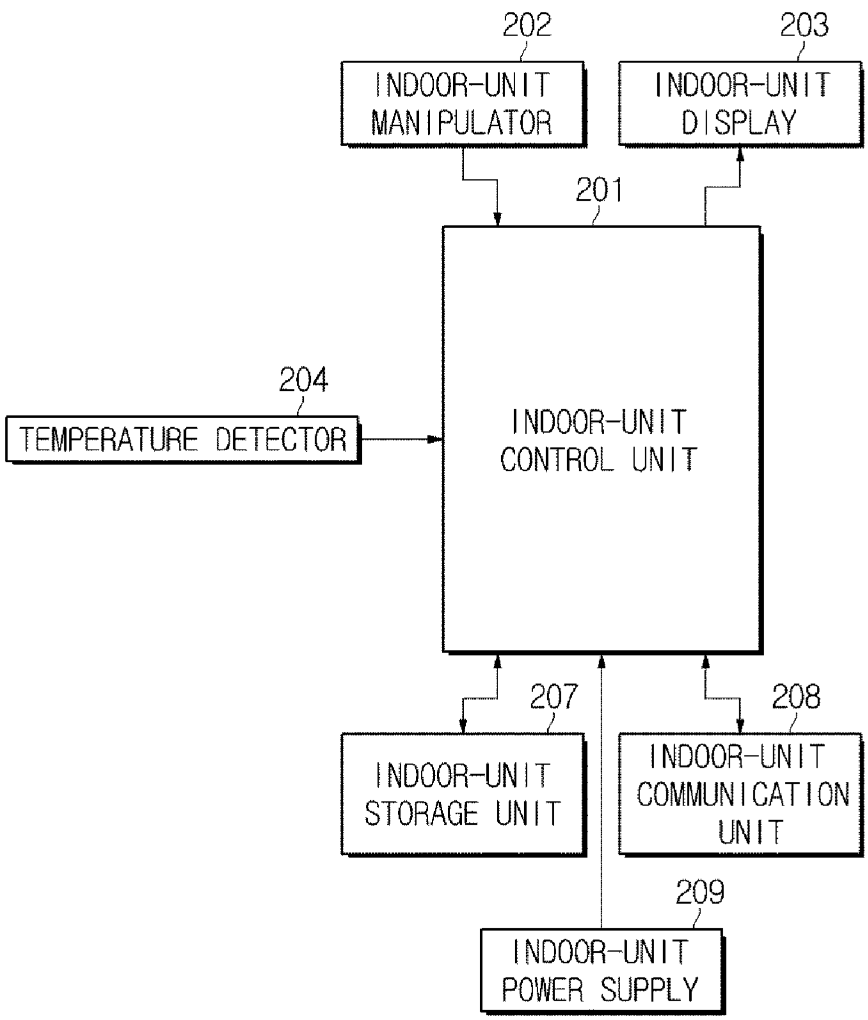
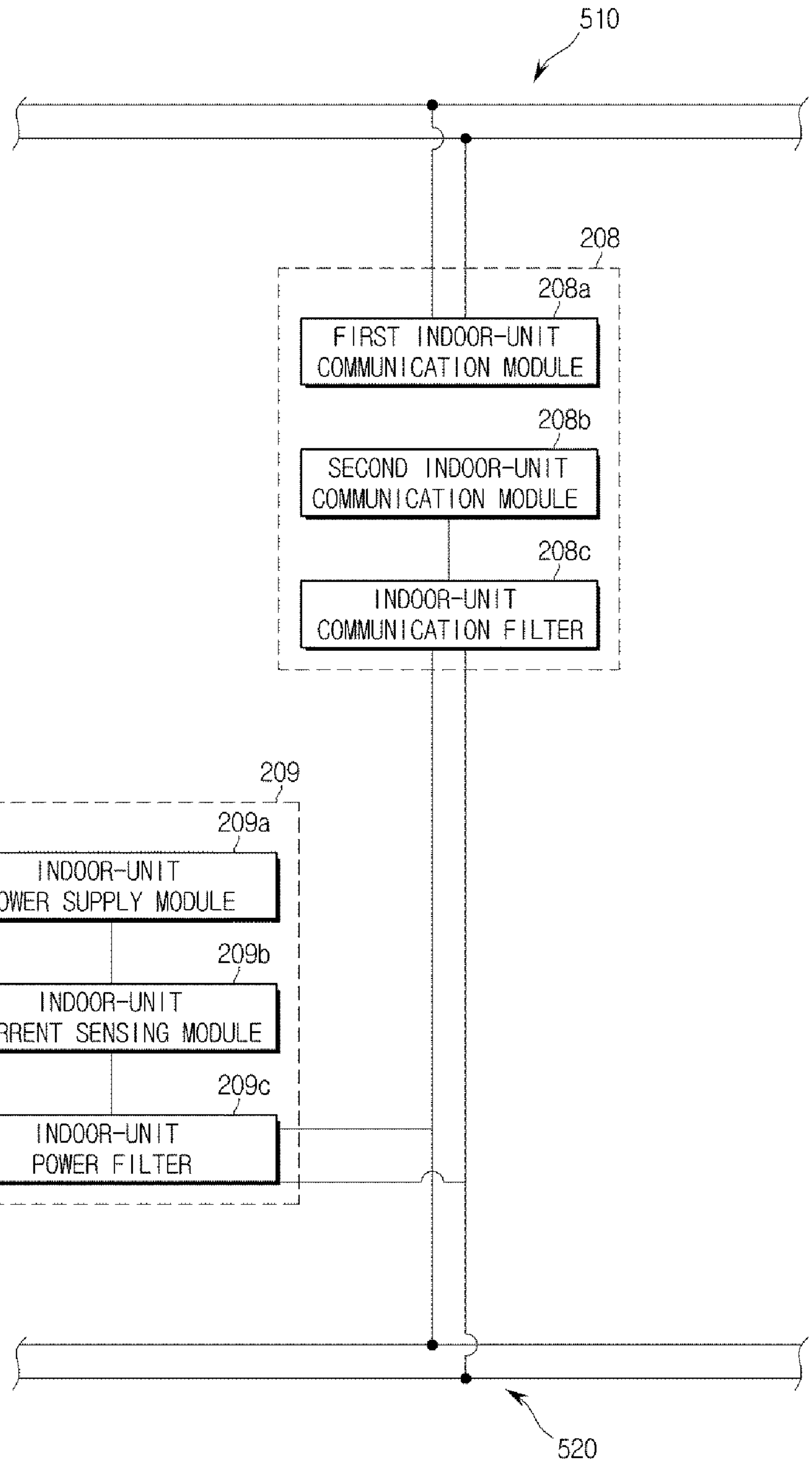

102
OUTDOOR-UNIT MANIPULATOR
103
OUTDOOR-UNIT DISPLAY
101
OUTDOOR-UNIT CONTROL UNIT
106
OUTDOOR-UNIT DRIVER
110
COMPRESSOR
130
4-WAY VALVE
107
OUTDOOR-UNIT STORAGE UNIT
108
OUTDOOR-UNIT COMMUNICATION UNIT
109
OUTDOOR-UNIT POWER SUPPLY

FIG. 5A



202
INDOOR-UNIT MANIPULATOR
203
INDOOR-UNIT DISPLAY
201
204
TEMPERATURE DETECTOR
INDOOR-UNIT CONTROL UNIT
207
INDOOR-UNIT STORAGE UNIT
208
INDOOR-UNIT COMMUNICATION UNIT
209
INDOOR-UNIT POWER SUPPLY

FIG. 5B



510
208
208a
FIRST INDOOR-UNIT COMMUNICATION MODULE
208b
SECOND INDOOR-UNIT COMMUNICATION MODULE
208c
INDOOR-UNIT COMMUNICATION FILTER
209
209a
INDOOR-UNIT POWER SUPPLY MODULE
209b
INDOOR-UNIT CURRENT SENSING MODULE
209c
INDOOR-UNIT POWER FILTER
520

FIG. 6

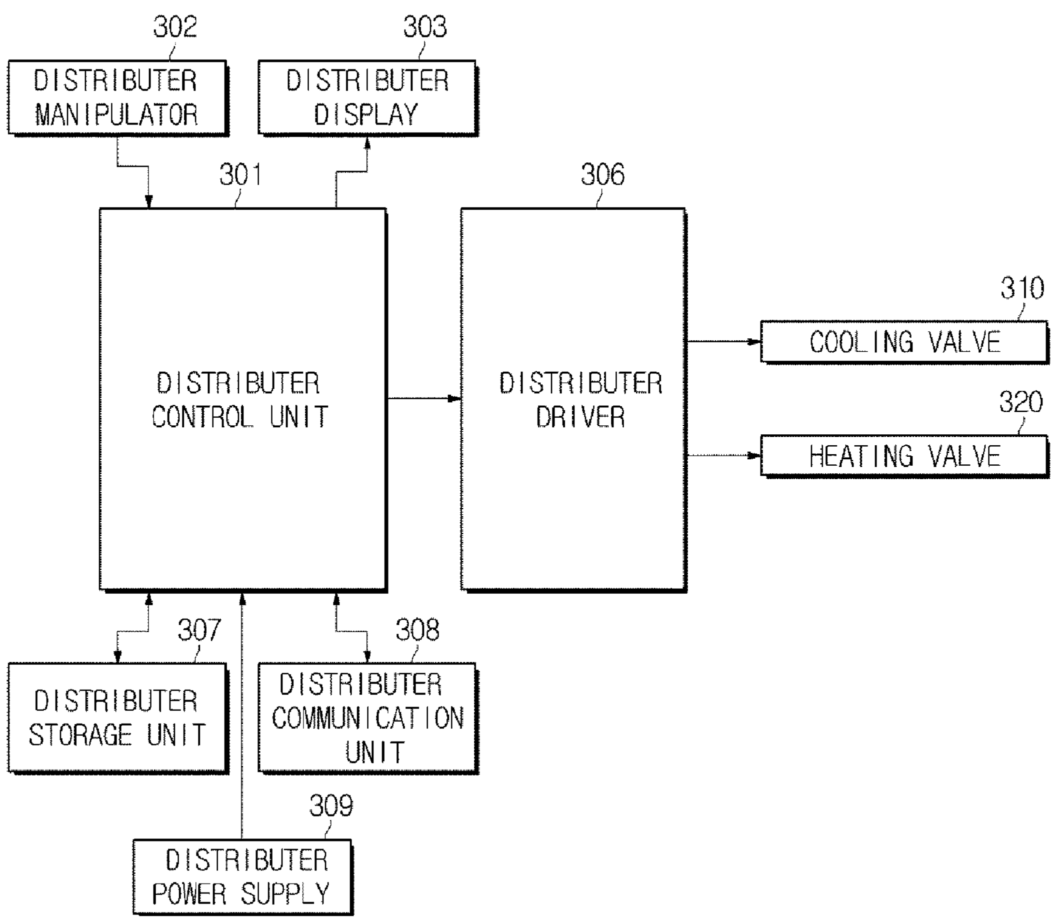

302
DISTRIBUTER MANIPULATOR
303
DISTRIBUTER DISPLAY
301
DISTRIBUTER CONTROL UNIT
306
DISTRIBUTER DRIVER
310
COOLING VALVE
320
HEATING VALVE
307
DISTRIBUTER STORAGE UNIT
308
DISTRIBUTER COMMUNICATION UNIT
309
DISTRIBUTER POWER SUPPLY

FIG. 7A

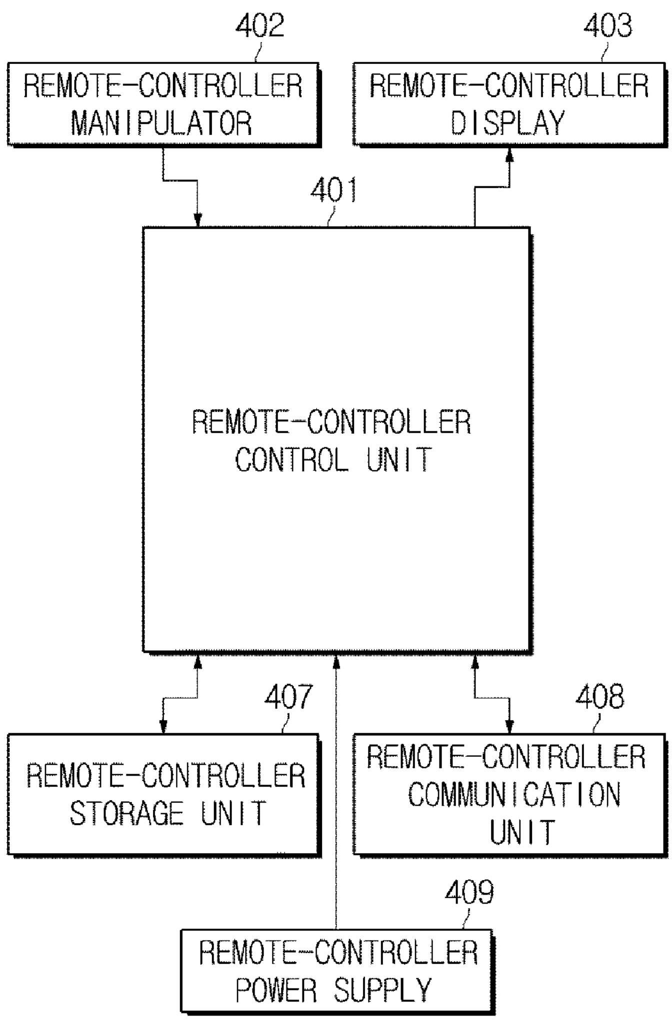

402
REMOTE-CONTROLLER MANIPULATOR
403
REMOTE-CONTROLLER DISPLAY
401
REMOTE-CONTROLLER CONTROL UNIT
407
REMOTE-CONTROLLER STORAGE UNIT
408
REMOTE-CONTROLLER COMMUNICATION UNIT
409
REMOTE-CONTROLLER POWER SUPPLY

FIG. 7B

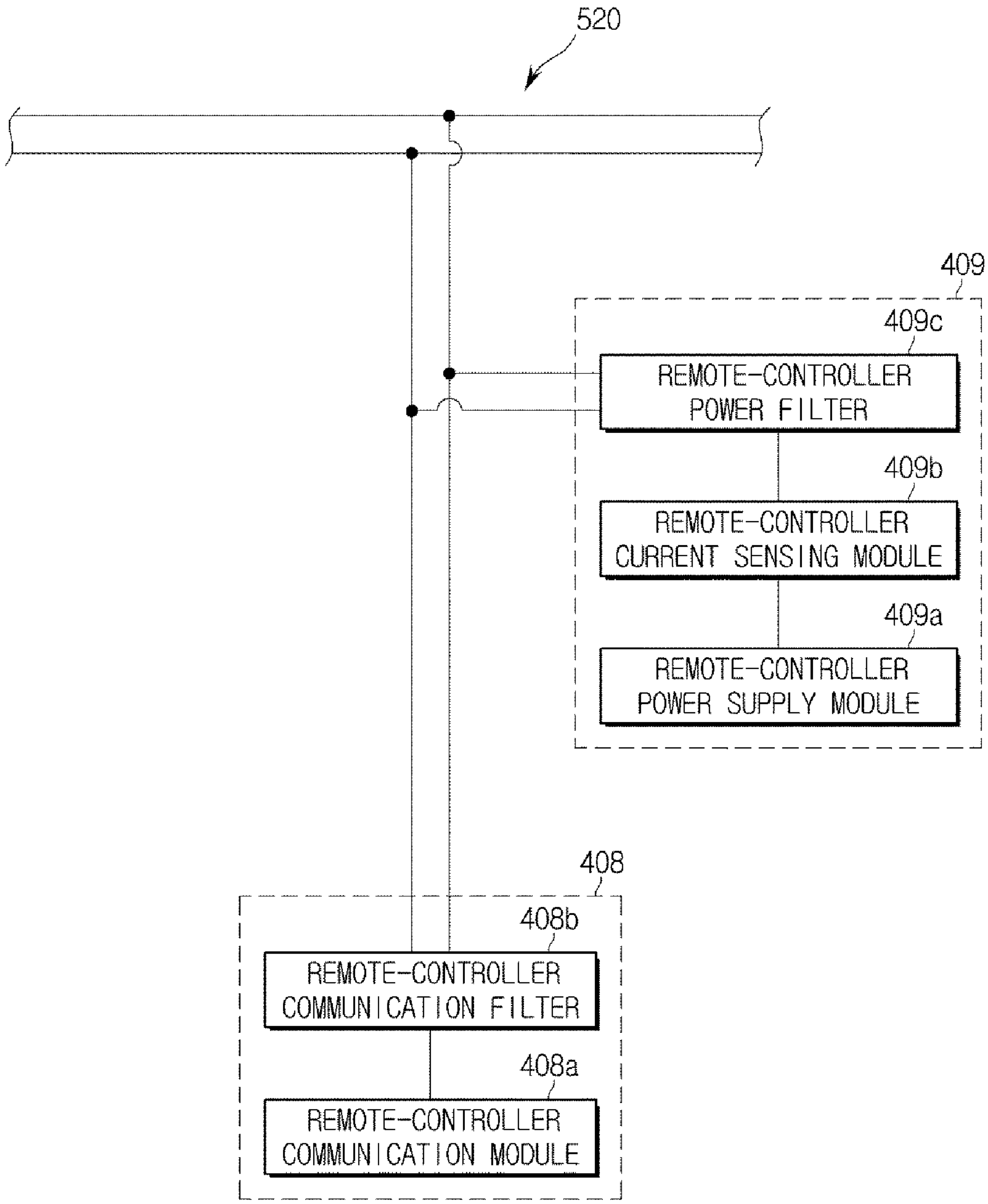
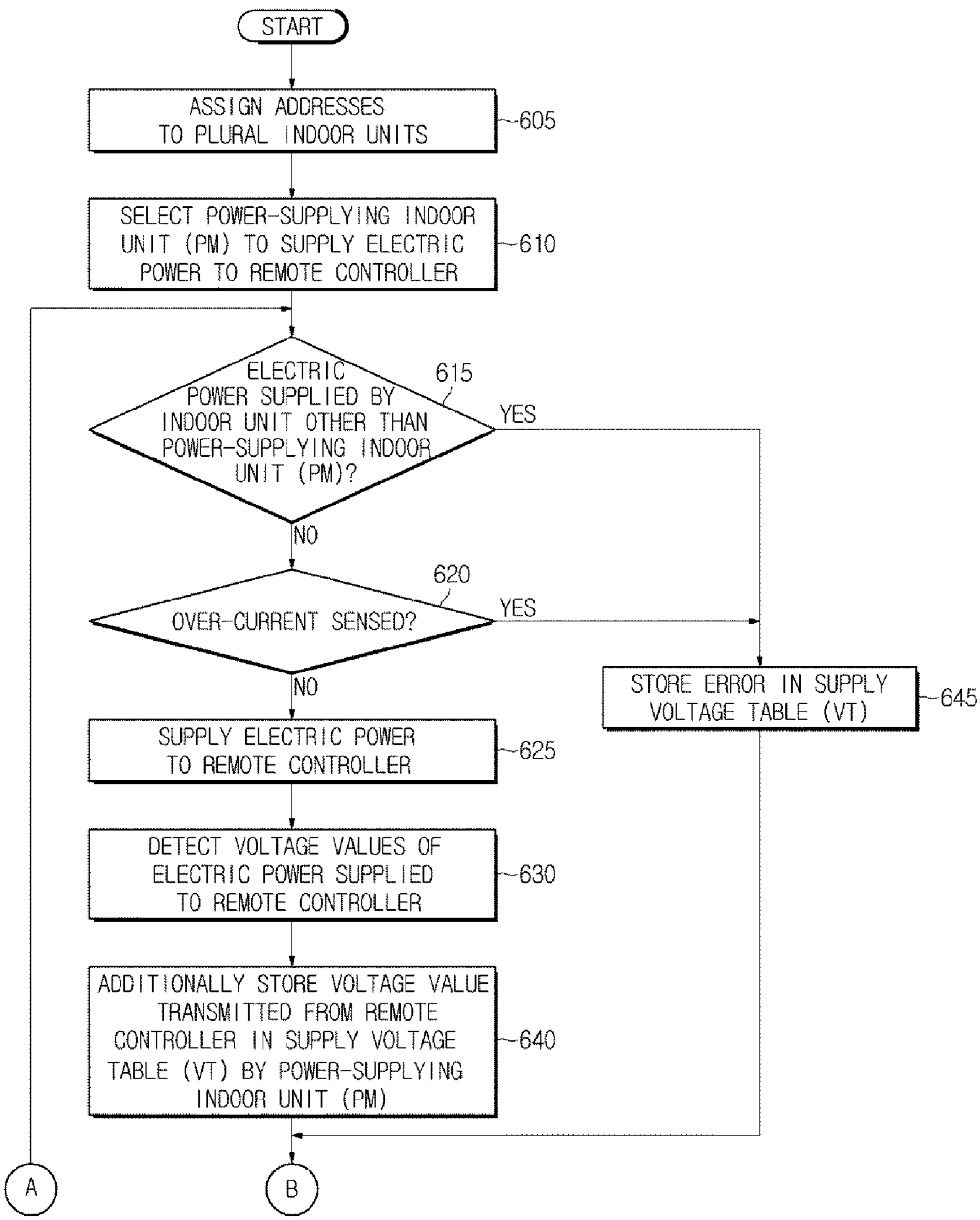

520
409
409c
REMOTE-CONTROLLER POWER FILTER
409b
REMOTE-CONTROLLER CURRENT SENSING MODULE
409a
REMOTE-CONTROLLER POWER SUPPLY MODULE
408
408b
REMOTE-CONTROLLER COMMUNICATION FILTER
408a
REMOTE-CONTROLLER COMMUNICATION MODULE

FIG. 8A



START
ASSIGN ADDRESSES TO PLURAL INDOOR UNITS
605
SELECT POWER-SUPPLYING INDOOR UNIT (PM) TO SUPPLY ELECTRIC POWER TO REMOTE CONTROLLER
610
ELECTRIC POWER SUPPLIED BY INDOOR UNIT OTHER THAN POWER-SUPPLYING INDOOR UNIT (PM)?
615
YES
NO
OVER-CURRENT SENSED?
620
YES
NO
STORE ERROR IN SUPPLY VOLTAGE TABLE (VT)
645
SUPPLY ELECTRIC POWER TO REMOTE CONTROLLER
625
DETECT VOLTAGE VALUES OF ELECTRIC POWER SUPPLIED TO REMOTE CONTROLLER
630
ADDITIONALLY STORE VOLTAGE VALUE TRANSMITTED FROM REMOTE CONTROLLER IN SUPPLY VOLTAGE TABLE (VT) BY POWER-SUPPLYING INDOOR UNIT (PM)
640
A
B

FIG. 8B

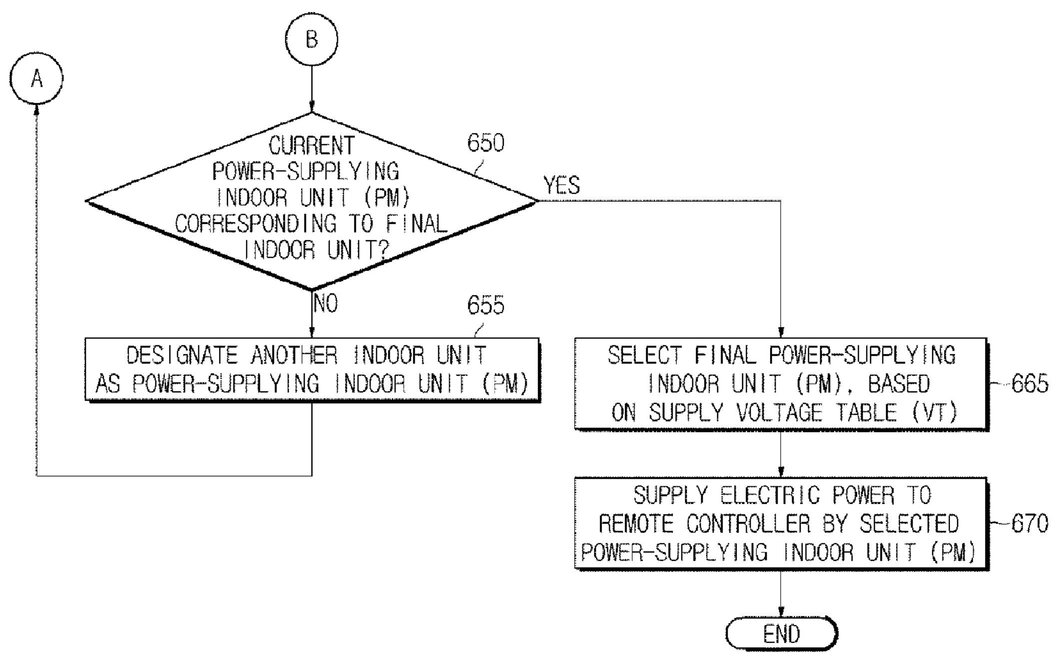

B
A
CURRENT POWER-SUPPLYING INDOOR UNIT (PM) CORRESPONDING TO FINAL INDOOR UNIT?
650
YES
NO
655
DESIGNATE ANOTHER INDOOR UNIT AS POWER-SUPPLYING INDOOR UNIT (PM)
SELECT FINAL POWER-SUPPLYING INDOOR UNIT (PM), BASED ON SUPPLY VOLTAGE TABLE (VT)
665
SUPPLY ELECTRIC POWER TO REMOTE CONTROLLER BY SELECTED POWER-SUPPLYING INDOOR UNIT (PM)
670
END

FIG. 9A

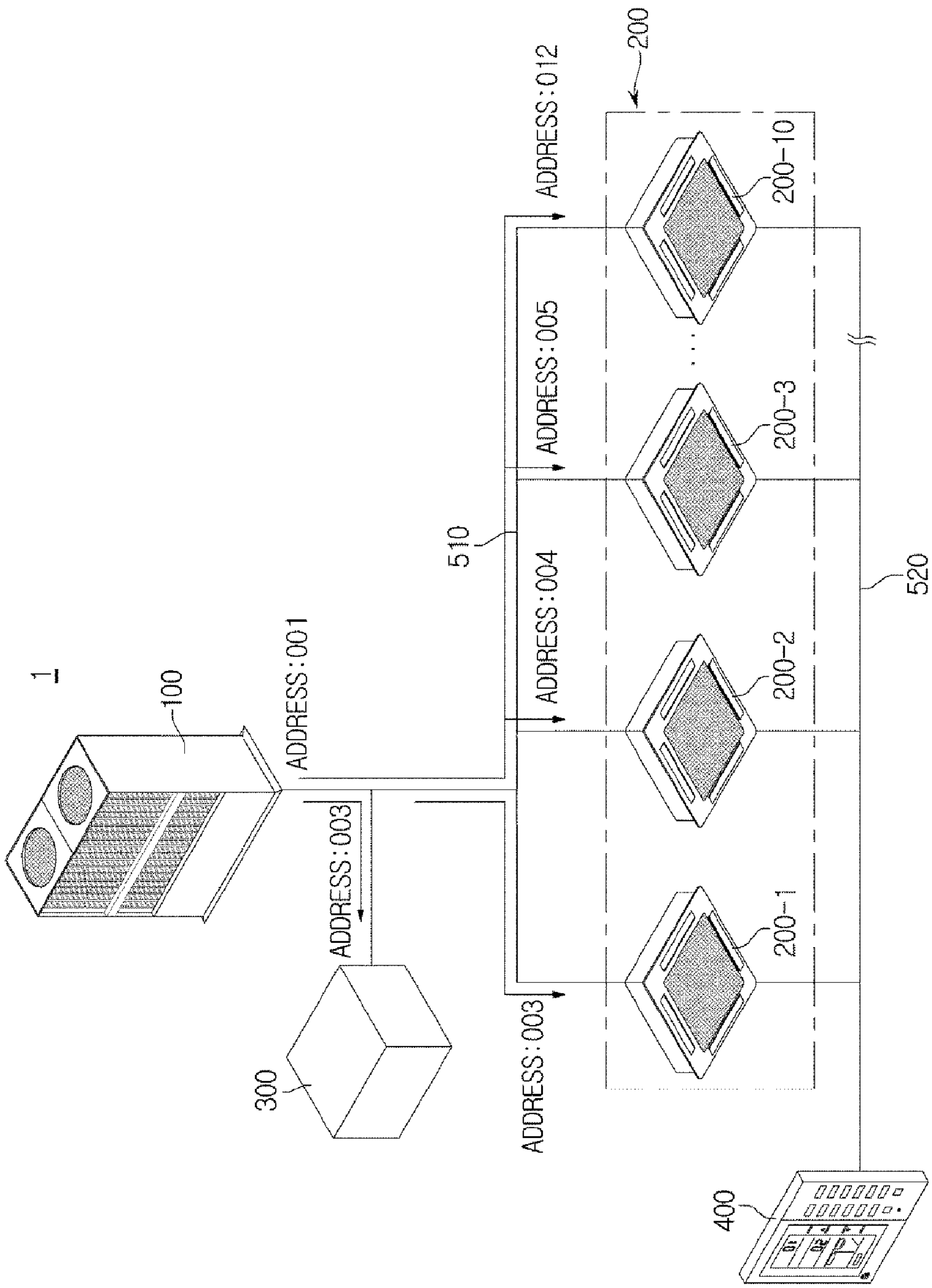

1
100
ADDRESS:001
ADDRESS:003
300
ADDRESS:003
ADDRESS:004
ADDRESS:005
ADDRESS:012
510
200
200-1
200-2
200-3
200-10
520
400

FIG. 9B

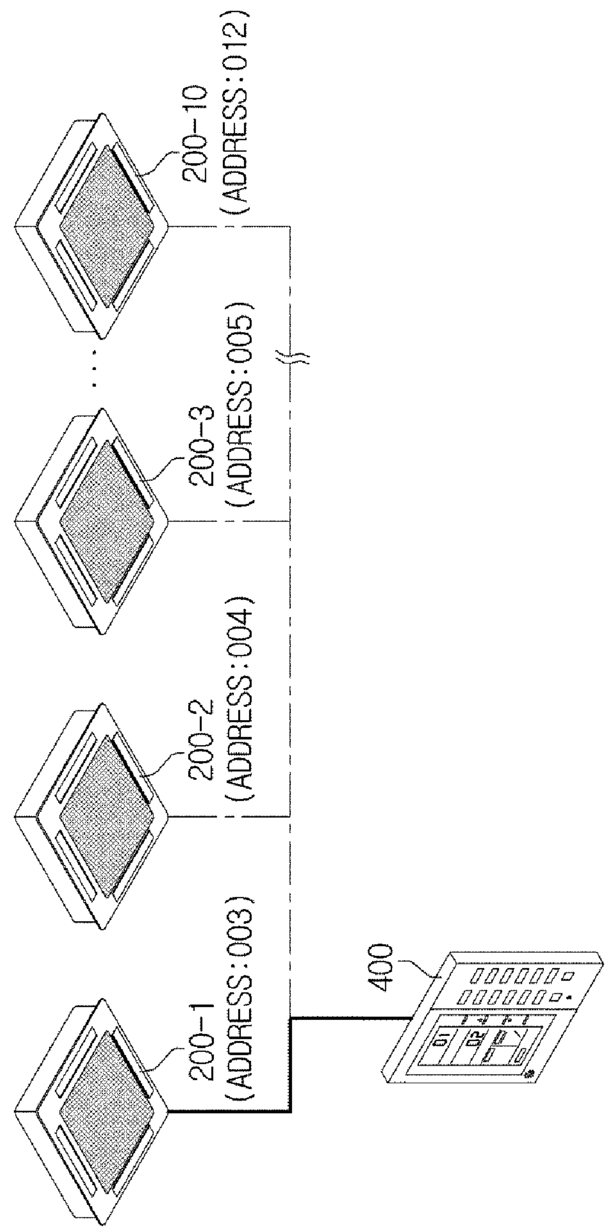

200-1
(ADDRESS:003)
200-2
(ADDRESS:004)
200-3
(ADDRESS:005)
200-10
(ADDRESS:012)
400

FIG. 9C

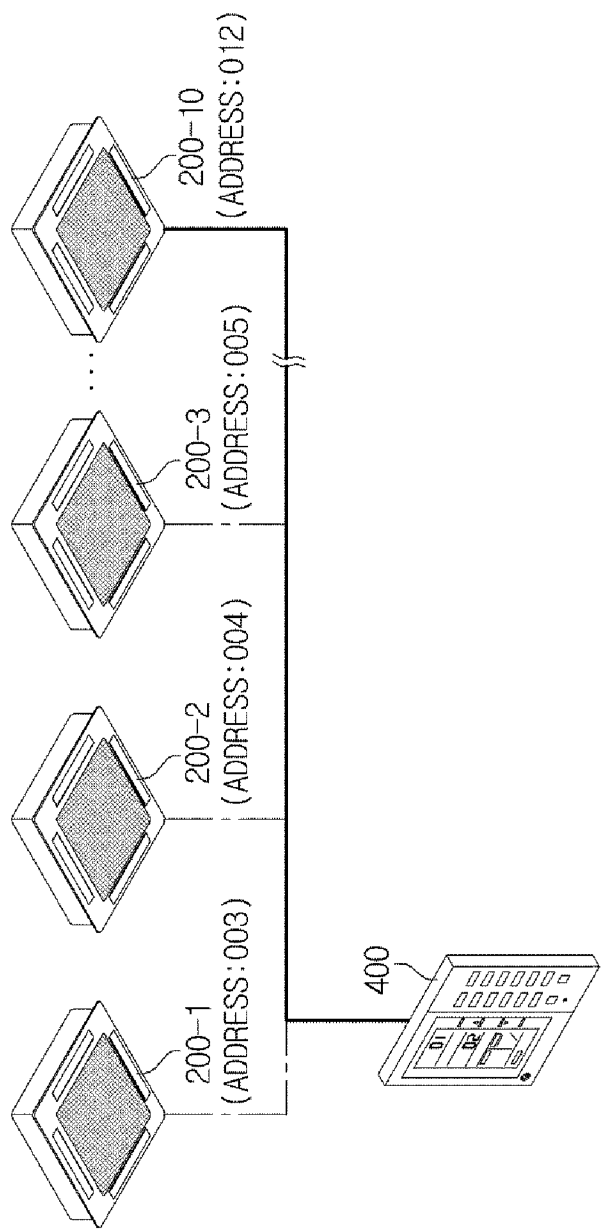
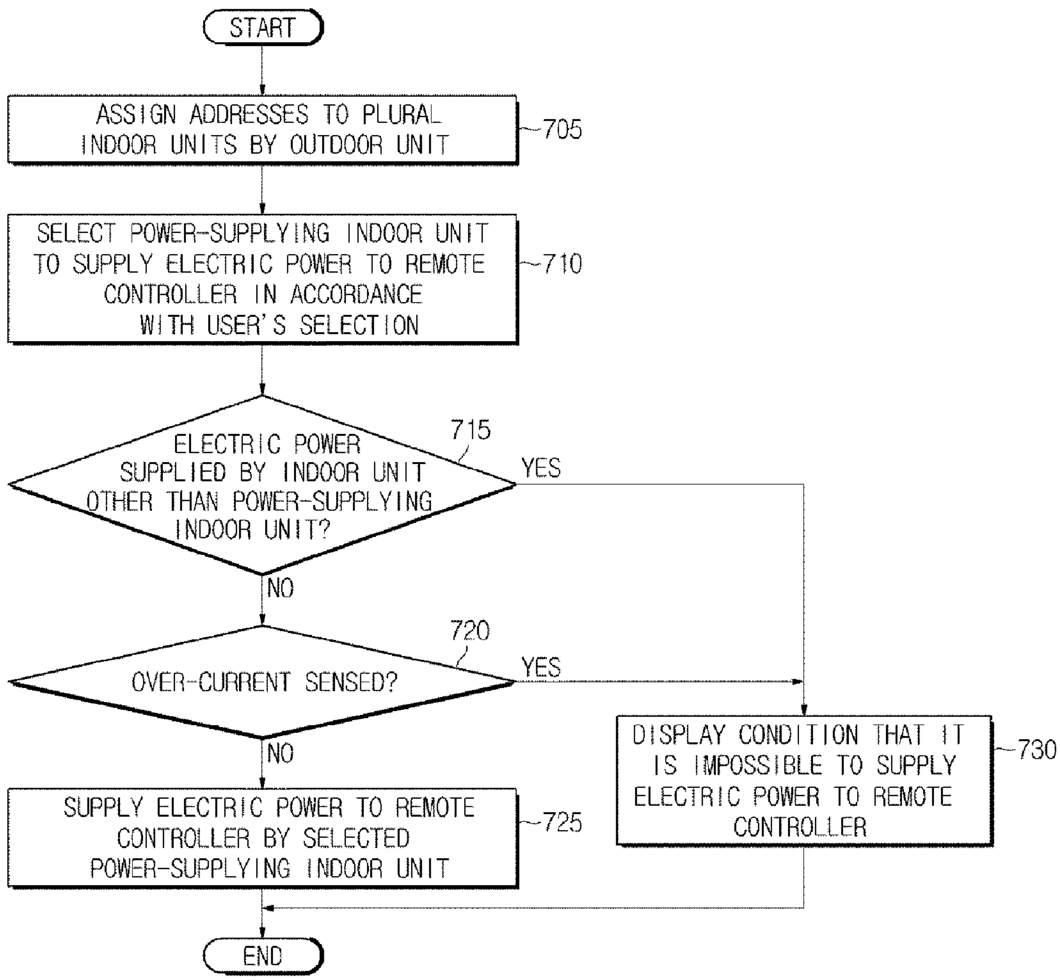

200-1
(ADDRESS:003)
200-2
(ADDRESS:004)
200-3
(ADDRESS:005)
200-10
(ADDRESS:012)
400

FIG. 9D

SUPPLY VOLTAGE TABLE (VT)

ADDRESS	VOLTAGE VALUE
003	11.9V
004	11.8V
005	11.6V
⋮	⋮
012	10.0V

FIG. 10


START
ASSIGN ADDRESSES TO PLURAL INDOOR UNITS BY OUTDOOR UNIT
705
SELECT POWER-SUPPLYING INDOOR UNIT TO SUPPLY ELECTRIC POWER TO REMOTE CONTROLLER IN ACCORDANCE WITH USER'S SELECTION
710
ELECTRIC POWER SUPPLIED BY INDOOR UNIT OTHER THAN POWER-SUPPLYING INDOOR UNIT?
715
YES
NO
OVER-CURRENT SENSED?
720
YES
NO
SUPPLY ELECTRIC POWER TO REMOTE CONTROLLER BY SELECTED POWER-SUPPLYING INDOOR UNIT
725
DISPLAY CONDITION THAT IT IS IMPOSSIBLE TO SUPPLY ELECTRIC POWER TO REMOTE CONTROLLER
730
END

AIR CONDITIONER AND CONTROL METHOD THEREOF

CROSS-REFERENCE TO RELATED APPLICATIONS

This application is related to, and claims priority to, Korean Patent Application No. 10-2013-0075597 filed on Jun. 28, 2013 in the Korean Intellectual Property Office, the disclosure of which is incorporated herein by reference.

BACKGROUND

1. Field

Embodiments of the present invention relate to an air conditioner including a remote controller and a control method thereof.

2. Description of the Related Art

A multi-type air conditioner, which is an air conditioning system, includes one or more outdoor units and one or more indoor units, to execute centrally-controlled air conditioning for the entirety of a building or one story of the building.

Such a multi-type air conditioner generally includes one or more remote controllers (e.g., wired remote controllers) in order to input operation commands for two or more indoor units. For example, in a multi-type air conditioner including five (5) indoor units for each story of a 10-story building, one remote controller is provided to each floor, to collectively input an operation command for the five (5) indoor units on the floor.

In this case, generally, the remote controller does not directly receive external electric power such as commercial electric power, but receives electric power from one of the indoor units connected to the remote controller.

The indoor unit to supply electric power to the remote controller may be randomly set. For example, the indoor unit assigned a lowest address value or the indoor unit assigned a highest address value is set to supply electric power to the remote controller.

However, when the distance between the remote controller and the indoor unit to supply electric power to the remote controller is very long, it may be difficult to supply electric power with a sufficiently high voltage to the remote controller due to voltage drop occurring at a power line to connect the remote controller to the indoor unit.

SUMMARY

It is an aspect of the present invention to provide a multi-type air conditioner that includes a remote controller, and is configured to supply electric power with a sufficiently high voltage to the remote controller.

Additional aspects of the invention will be set forth in part in the description which follows and, in part, will be obvious from the description, or may be learned by practice of the invention.

In accordance with an aspect of the present invention, an air conditioner includes at least one outdoor unit to execute heat exchange operation for heat exchange between outdoor air and refrigerant, a plurality of indoor units to execute heat exchange operation for heat exchange between indoor air and the refrigerant, and at least one remote controller to receive operation commands for the plural indoor units, wherein one of the plural indoor units may be selected as a power-supplying indoor unit to supply electric power to the at least one remote controller, based on voltage values of electric power to be supplied from the plural indoor units to

the at least one remote controller, and the selected indoor unit supplies electric power to the at least one controller.

The power-supplying indoor unit may supply electric power to the at least one remote controller via a communication line, through which communications between the plural indoor units and the at least one remote controller are executed.

The communication line may transmit DC power supplied from the power-supplying indoor unit to the at least one remote controller while transmitting high-frequency communication signals from the plural indoor units or from the at least one remote controller.

The remote controller may include a remote-controller power supply module to receive the DC power supplied from the power-supplying indoor unit via the communication line, and a remote-controller power filter to block the high-frequency communication signals.

Each of the plural indoor units may include an indoor-unit power supply module to supply the DC power to the remote controller via the communication line, and an indoor-unit power filter to block the high-frequency communication signals.

When the plural indoor units supply electric power to the at least one remote controller in accordance with a predetermined sequence, the at least one remote controller may detect voltage values of the electric power supplied from the plural indoor units.

The plural indoor units may supply electric power to the at least one remote controller in accordance with a predetermined sequence based on addresses of the plural indoor units.

Each of the plural indoor unit may determine whether another one of the plural indoor unit supplies electric power to the at least one remote controller, and may supply electric power to the at least one remote controller when it is determined that there is no indoor unit supplying electric power to the at least one remote controller.

Each of the plural indoor unit may determine whether over-current flows through the communication line, and may supply electric power to the at least one remote controller when it is determined that no over-current flows through the communication line.

The power-supplying indoor unit may be selected from among the plural indoor units, based on the voltage values detected by the at least one remote controller.

When the at least one remote controller includes a single remote controller, one of the plural indoor units, which supplies electric power with a highest voltage value detected by the single remote controller, may be selected as the power-supplying indoor unit from among the plural indoor units.

When the at least one remote controller includes at least two remote controllers, one of the plural indoor units, which supplies electric power with a highest average of voltage values detected by the at least two remote controllers, may be selected as the power-supplying indoor unit from among the plural indoor units.

In accordance with an aspect of the present invention, a method for controlling an air conditioner including at least one outdoor unit to execute heat exchange operation for heat exchange between outdoor air and refrigerant, a plurality of indoor units to execute heat exchange operation for heat exchange between indoor air and the refrigerant, and at least one remote controller to receive operation commands for the plural indoor units, includes supplying electric power to the at least one remote controller by each of the plural indoor units, detecting voltage values of the electric power respectively supplied from the plural indoor units by the at least one remote controller, and selecting a power-supplying indoor unit to supply electric power to the at least one remote controller, based on the detected voltage values, by the at least one remote controller.

The power-supplying indoor unit may supply electric power to the at least one remote controller via a communication line, through which communications between the plural indoor units and the at least one remote controller are executed.

The communication line may transmit DC power supplied from the power-supplying indoor unit to the at least one remote controller while transmitting high-frequency communication signals from the plural indoor units or from the at least one remote controller.

The supplying electric power to the at least one remote controller by each of the plural indoor units may include supplying electric power to the at least one remote controller by the plural indoor units in accordance with a predetermined sequence based on addresses of the plural indoor units.

The supplying electric power to the at least one remote controller by each of the plural indoor units may further include, by each of the plural indoor unit, determining whether another one of the plural indoor unit supplies electric power to the at least one remote controller, and supplying, and supplying electric power to the at least one remote controller when it is determined that there is no indoor unit supplying electric power to the at least one remote controller.

The supplying electric power to the at least one remote controller by each of the plural indoor units may further include, by each of the plural indoor unit, determining whether over-current flows through the communication line, and supplying electric power to the at least one remote controller when it is determined that no over-current flows through the communication line.

When the at least one remote controller includes a single remote controller, the selecting the power-supplying indoor unit may include selecting one of the plural indoor units, which supplies electric power with a highest voltage value detected by the single remote controller, as the power-supplying indoor unit from among the plural indoor units.

When the at least one remote controller includes at least two remote controllers, the selecting the power-supplying indoor unit may include selecting one of the plural indoor units, which supplies electric power with a highest average of voltage values detected by the at least two remote controllers, as the power-supplying indoor unit from among the plural indoor units.

BRIEF DESCRIPTION OF THE DRAWINGS

These and/or other aspects of the invention will become apparent and more readily appreciated from the following description of the embodiments, taken in conjunction with the accompanying drawings of which:

FIG. **1** illustrates an exemplary air conditioner according to an embodiment;

FIG. **2** illustrates exemplary flow of refrigerant in an air conditioner according to an embodiment;

FIG. **3** illustrates exemplary flows of communication signals in the air conditioner according to an embodiment;

FIG. **4** illustrates exemplary flows of controls signals in an outdoor unit included in the air conditioner according to an embodiment;

FIG. **5**A illustrates exemplary flows of control signals in each indoor unit included in an air conditioner according to an embodiment;

FIG. **5**B illustrates an exemplary indoor-unit power supply unit and an indoor-unit communication unit, which are included in the air conditioner according to an embodiment;

FIG. **6** illustrates exemplary flows of control signals in a distributer included in the air conditioner according to an embodiment;

FIG. **7**A illustrates exemplary flows of control signals in a remote controller included in the air conditioner according to an embodiment;

FIG. **7**B illustrates an exemplary remote-controller power supply and a remote-controller communication unit, which are included in an air conditioner according to an embodiment;

FIGS. **8**A and **8**B illustrate an exemplary method for controlling the air conditioner according to an embodiment to automatically select one indoor unit to supply electric power to the remote controller;

FIGS. **9**A to **9**D illustrate an exemplary procedure of controlling the air conditioner according to an embodiment to select one indoor unit to supply electric power to the remote controller; and

FIG. **10** illustrates an exemplary method for controlling the air conditioner to select one indoor unit to supply electric power to the remote controller in accordance with a user's selection.

DETAILED DESCRIPTION

Reference will now be made in detail to the exemplary embodiments of the present invention, examples of which are illustrated in the accompanying drawings.

FIG. **1** illustrates an exemplary configuration of an air conditioner according to an embodiment.

Referring to FIG. **1**, the air conditioner, which is designated by reference character "**1**", includes an outdoor unit **100** disposed in an outdoor space, to execute heat exchange operation for heat exchange between outdoor air and refrigerant, and indoor units **200-1**, **200-2**, **200-3**, . . . , and **200-*n*** (also, collectively referred to as "**200**") respectively disposed in indoor spaces, to execute heat exchange operation for heat exchange between indoor air and refrigerant. The air conditioner **1** also includes a distributer **300** to distribute refrigerant supplied from the outdoor unit **100** to the indoor units **200**, for selective execution of cooling or heating, and a remote controller **400** to receive an operation command from the user in association with the indoor units **200**.

An exemplary flow of refrigerant and flows of signals in a separate manner such that flow of refrigerant in the air conditioner and flows of signals in an air conditioner are disclosed.

FIG. **2** illustrates an exemplary flow of refrigerant in the air conditioner according to an embodiment.

Referring to FIG. **1** and FIG. **2**, the air conditioner **1** includes, as a configuration associated with flow of refrigerant, the outdoor unit **100**, the indoor units **200**, and the distributer **300**.

The outdoor unit **100** includes a compressor **110** to compress gas-phase refrigerant, an outdoor heat exchanger **120** to execute heat exchange operation for heat exchange between outdoor air and refrigerant, and a 4-way valve **130** to selectively guide refrigerant discharged from the compressor **110** to the outdoor heat exchanger **120** or to the indoor units **200**. The outdoor unit **100** includes an outdoor expansion valve **140** to reduce pressure of refrigerant guided to the outdoor heat exchanger **120** during heating operation, and an accumulator **150** to prevent liquid-phase refrigerant from being introduced into the compressor **110**.

The indoor units **200** include respective indoor heat exchangers **210-1**, **210-2**, **210-3**, . . . , and **210-*n*** (also collectively referred to as "**210**") to execute heat exchange operation for heat exchange between indoor air and refrigerant, and respective indoor expansion valves **220-1**, **220-2**, **220-3**, . . . , and **220-*n*** (also collectively referred to as "**220**") to reduce pressure of refrigerant supplied to respective indoor heat exchanges **210** during cooling operation.

The distributer **300** includes cooling valves **310-1**, **310-2**, **310-3**, . . . , and **310-*n*** (also collectively referred to as "**310**") and heating valves **320-1**, **320-2**, **320-3**, . . . , and **320-*n*** (also collectively referred to as "**320**") arranged between the outdoor unit **100** and the indoor units **200**, e.g., between refrigerant lines to guide refrigerant supplied from the outdoor unit **110** to respective indoor units **200**, to control flows of refrigerant in accordance with an operation mode of the air conditioner **1**, namely, a cooling mode or a heating mode.

Exemplary circulation of refrigerant is disclosed. An exemplary circulation with one indoor unit **200** is described for simplicity. When the air conditioner **1** is in a cooling mode, refrigerant is compressed to high pressure by the compressor **110** of the outdoor unit **100**. The compressed refrigerant may be guided to the outdoor heat exchanger **120** by the 4-way valve **130**. The compressed refrigerant may be condensed in the outdoor heat exchanger **120**. During condensation, the refrigerant discharges latent heat into outdoor air. The condensed refrigerant is selectively guided to the indoor unit **200** via the distributer **300**.

The refrigerant guided to the indoor unit **200** may be pressure-reduced while passing through the indoor expansion valve **220** included in the indoor unit **200**, and evaporated in the indoor heat exchanger **210**. During evaporation, the refrigerant absorbs latent heat from indoor air. Thus, in the cooling mode, indoor air may be cooled in accordance with heat exchange between refrigerant passing through the indoor heat exchanger **210** and indoor air.

The evaporated refrigerant may be guided to the outdoor unit **100** via the cooling valve **310** included in the distributer **300**. In the accumulator **150** of the outdoor unit **100**, the refrigerant may be separated into unevaporated liquid-phase refrigerant and evaporated gas-phase refrigerant. The gas-phase refrigerant is then supplied to the compressor **110**.

The refrigerant guided to the compressor **110** is compressed, and supplied to the 4-way valve **130** and, as such, the refrigerant circulation is repeated.

In a cooling mode, the air conditioner **1** discharges heat from an indoor space to the outdoors by absorbing heat from indoor air by the indoor unit **200**, and discharging the absorbed heat to the outdoors by the outdoor unit **100**.

When the air conditioner **1** is in a heating mode, refrigerant is compressed to high pressure by the compressor **110** of the outdoor unit **100**. The compressed refrigerant is guided to the distributer **130** by the 4-way valve **130**. The refrigerant may be selectively guided from the distributer **200** to the indoor unit **200** via the heating valve **320** of the distributer **300**.

The refrigerant is condensed in the indoor heat exchanger **210** included in the indoor unit **200**. During condensation, the refrigerant discharges latent heat into indoor air. Thus, in the heating mode, indoor air may be heated in accordance with heat exchange between refrigerant passing through the indoor heat exchanger **210** and indoor air. The condensed refrigerant may be guided to the outdoor unit **100** via the distributer **300** after being pressure-reduced by the indoor expansion valve **220**.

The refrigerant guided to the outdoor unit **10** may be pressure-reduced while passing through the outdoor expansion valve **140** included in the outdoor unit **100**, and then evaporated in the outdoor heat exchanger **120**. In the accumulator **150**, the evaporated refrigerant may be separated into unevaporated liquid-phase refrigerant and evaporated gas-phase refrigerant. The gas-phase refrigerant is supplied to the compressor **110**. The refrigerant guided to the compressor **110** is compressed, and supplied to the 4-way valve **130** and, as such, the refrigerant circulation is repeated.

In the heating mode, the air conditioner **1** transfers heat from the outdoors to an indoor space by absorbing heat from outdoor air via the outdoor unit **100**, and discharging the absorbed heat to the indoor space by the indoor unit **200**.

Exemplary flows of signals among configurations in an air conditioner are disclosed. To assist in understanding of flows of signals, the elements of the air conditioner such as the outdoor unit, indoor unit, and distributer will be collectively referred to as "included units" in the following description.

FIG. **3** is a view illustrating configurations associated with flows of communication signals in the air conditioner according to an embodiment.

Referring to FIG. **3**, the air conditioner **1** includes, in association with flows of signals, the outdoor unit **100**, the indoor units **200**, the distributer **300**, the remote controller **400**, and a communication line **510-520** to connect the included units **100**, **200**, **300**, and **400** included in the air conditioner **1**.

The included units **100**, **200**, **300**, and **400** included in the air conditioner **1** may be spaced apart from one another by a considerable distance. For example, when one indoor unit **200** is disposed on each floor in a 10-story building with each floor being approximately 2.5 m in height, there is a distance of at least approximately 25 m between the 10th indoor unit **200-10** disposed at the 10th story and the first indoor unit **200-1** disposed at the first story.

Due to distances among the included units **100**, **200**, **300**, and **400**, requests and responses among the included units **100**, **200**, **200**, and **400** may be transferred through communications using the communication line **510-520**. When the first indoor unit **200-1** disposed at the first story is required to execute a cooling operation for an indoor space at the first story, the first indoor unit **200-1** sends a signal requesting circulation of refrigerant to the outdoor unit **100** via the communication line **510-520**. In response to the signal from the first indoor unit **200-1**, the outdoor unit **100** sends, to the first indoor unit **200-1** via the communication line **510-520**, a signal indicating reception of the request from the first indoor unit **200-1**. The outdoor unit **100** operates the compressor **110** (see, for example, FIG. **2**), and sends, to the distributer **300** via the communication line **510-520**, a signal requesting opening of the cooling valve to supply refrigerant to the first indoor unit **200-1**. In response to the signal from the outdoor unit **100**, the distributer **300** sends a signal indicating reception of the request from the outdoor unit **100** via the communication line **510-520**.

The communication line **510-520** includes a first communication line **510** to connect the outdoor unit, indoor unit **200**, and distributer **300**, and a second communication line **520** to connect the indoor unit **200** and remote controller **400**. The types of a first communication line **510** and a second communication line **520** may be varied in accordance with a protocol applied to the air conditioner **1**. For example, when the air conditioner **1** utilizes Recommended

Standard-485 (RS-485) protocol for a half duplex communication system in association with communications among the included units **100**, **200**, **300**, and **400**, each of the communication lines **510** and **520** may include a pair of communication wires, namely, a plus (+) communication wire and a minus (−) communication wire. When the air conditioner **1** utilizes Recommended Standard-232C (RS-232C) protocol for a full duplex communication system in association with communications among the included units **100**, **200**, **300**, and **400**, each of the communication lines **510** and **520** may include three communication wires, namely, a transmitting wire Tx, a receiving wire Rx, and a ground wire Gnd.

An exemplary embodiment of communications in the air conditioner **1** that utilizes the RS-485 communication system is described. Exemplary embodiments are not limited to use of RS-485.

A remote controller **400** does not directly receive electric power from an external power source, but may receive electric power from one of the plural indoor units **200**. The second communication line **520**, which connects each indoor unit **200** and the remote controller **400**, may serve as a path for communication signals between the indoor unit **200** and the remote controller **400**, and as a path to supply electric power from the indoor unit **200** to the remote controller **400**. In other words, the indoor units **200** transmit and receive high-frequency communication signals to, and from, the remote controller **400** via a pair of communication lines serving as communication paths, and one of the indoor units **200** supplies DC power to the remote controller **400**.

Information of requests and responses transmitted through the communication lines **510** and **520** may be transmitted in the form of frames, each of which a header and a data payload. The header area contains the address of the included unit to transmit a data frame, the address of the included unit to receive the data frame, and information associated with data, for example, the kind of the actual data. The contents to be transmitted by the included unit to transmit the data frame are written on the actual data area. Hereinafter, the "data frame" is referred to as "data", for convenience of description.

FIG. **4** illustrates exemplary flows of controls signals in the outdoor unit included in the air conditioner according to an embodiment.

Referring to FIG. **4**, the outdoor unit **100** includes an outdoor-unit manipulator **102** to receive operation commands associated with the outdoor unit **100** or air conditioner **1** from the user or operator, an outdoor-unit display **103** to display operation information of the outdoor unit **100** or air conditioner **1**, and an outdoor-unit driver **106** to drive the compressor **110**, 4-way valve **130**, heating bypass valve **160**, and cooling bypass valve **170** included in the outdoor unit **100**. The outdoor unit **100** includes an outdoor-unit storage unit **107** to store programs and data associated with operation of the outdoor unit **100**, an outdoor-unit communication unit **108** to communicate with the indoor units **200** and distributer **300** included in the air conditioner **1**, an outdoor-unit power supply **109** to supply electric power to the included elements of the outdoor unit **100**, and an outdoor-unit control unit **101** to control operation of each included element of the outdoor unit **100**.

The outdoor-unit manipulator **102** may include button switches, membrane switches, or a touch panel to receive operation commands associated with the outdoor unit **100** or air conditioner **1**. The outdoor-unit display **103** may include a liquid crystal display (LCD) panel or a light emitting diode (LED) panel to display operation information of the outdoor unit **100** or air conditioner **1**. The outdoor-unit manipulator **102** and outdoor-unit display **103** may be integrated in the form of a touch screen panel (TSP).

The outdoor-unit driver **106** drives the compressor **110**, and 4-way valve **130** in accordance with control signals from the outdoor-unit control unit **101**. The outdoor-unit driver **106** may include an inverter to supply drive current to a compressor motor (not shown) in order to drive the compressor **110**.

The outdoor-unit storage unit **107** may include a non-volatile memory (not shown) such as a magnetic disc or a solid state drive to permanently store programs and data associated with operation of the outdoor unit **100**. The outdoor-unit storage unit **107** may include a volatile memory (not shown) such as a D-RAM or an S-RAM to temporarily store temporary data produced during operation of the outdoor unit **100**.

The outdoor-unit communication unit **108** may include a communication module (not shown) to execute communication with the indoor units **200** and distributer **300**, using a communication system such as an RS-485 communication system.

The outdoor-unit power supply **109** may include a rectifying circuit (not shown) to rectify external electric power, and a smoothing circuit (not shown) to remove ripples from the rectified electric power.

The outdoor-unit control unit **101** controls operation of each included element included in the outdoor unit **100**. For example, when the outdoor-unit control unit **101** receives a request for cooling from the third indoor unit **200-3** via the outdoor-unit communication unit **108**, the outdoor-unit control unit **101** controls the outdoor-unit communication unit **108**, to transmit a cooling request reception signal to the third indoor unit **300-3**. The outdoor-unit control unit **101** also controls the outdoor-unit driver **106**, to operate the compressor **110**. The outdoor-unit control unit **101** controls the communication unit **108**, to transmit a signal requesting opening of the third cooling valve **310-3** (see, for example, FIG. **2**) to the distributer **300**. The outdoor-unit control unit **101** may include a single general processor to execute all arithmetic operations associated with operation of the outdoor unit **100**, or a processor to execute specialized arithmetic operations, for example, a communication process to only execute arithmetic operations associated with communications, or a control processor to only execute arithmetic operations associated with control operations.

FIG. **5**A illustrates exemplary flows of control signals in each indoor unit included in the air conditioner according to an embodiment. FIG. **5**B illustrates an exemplary indoor-unit power supply unit and an indoor-unit communication unit, which are included in the air conditioner according to an embodiment.

Referring to FIGS. **5**A and **5**B, each indoor unit **200** includes an indoor-unit manipulator **202** to receive operation commands associated with the indoor unit **200** from the user, an indoor-unit display **203** to display operation information of the indoor unit **200**, a temperature detector **204** to detect a temperature of an indoor space where the indoor unit **200** is disposed, and an indoor-unit storage unit **207** to store programs and data associated with operation of the indoor unit **200**. The indoor unit **200** includes an indoor-unit communication unit **208** to communicate with another indoor unit **200**, the distributer **300**, and the remote controller **400**, an indoor-unit power supply **209** to supply electric power to the included elements of the indoor unit **200**, and an indoor-unit control unit **201** to control operation of each included element of the indoor unit **200**.

The indoor-unit manipulator **202** may include button switches, membrane switches, or a touch panel to receive operation commands associated with the indoor unit **200**. Since the air conditioner **1** includes the remote controller **400**, which receives operation commands associated with the indoor unit **200**, and displays operation information of the indoor unit **200**, the indoor-unit manipulator **202** of the indoor unit **200** may include only a power button (not shown) to supply electric power required by the indoor unit **200**.

The indoor-unit display **203** may include an LCD panel or an LED panel to display operation information of the indoor unit **200**. Since the air conditioner **1** includes the remote controller **400**, which receives operation commands associated with the indoor unit **200**, and displays operation information of the indoor unit **200**, the indoor-unit manipulator **202** of the indoor unit **200** may include a power supply display LED (not shown) to display whether electric power required by the indoor unit **200** is supplied and an operation display LED (not shown) to display whether the indoor unit **200** operates.

The temperature detector **204** senses a temperature of the indoor space where the indoor unit **200** is disposed, and outputs an electrical signal corresponding to the sensed temperature. The temperature detector **204** may include a thermistor, which exhibits variation in electrical resistance in accordance with variation in temperature.

The indoor-unit storage unit **207** may include a non-volatile memory (not shown) such as a magnetic disc or a solid state drive to permanently store programs and data associated with operation of the indoor unit **200**. The indoor-unit storage unit **207** may include a volatile memory (not shown) such as a D-RAM or an S-RAM to temporarily store temporary data produced during operation of the indoor unit **100**.

The indoor-unit communication unit **208** may include a first indoor-unit communication module **208***a* to execute communication with the outdoor unit **100**, other indoor units **200**, and the distributer **300** via the first communication line **510**, using RS-485 communication, and a second indoor-unit communication module **208***b* to execute communication with the remote controller **400** via the second communication line **520**. The indoor-unit communication unit **208** also includes an indoor-unit communication filter **208***c* to allow high-frequency communication signals received via the second communication line **520** to pass therethrough while preventing DC power received via the second communication line **520** from passing therethrough.

The second communication line **520** may transmit DC power and high-frequency communication signals in a simultaneous manner. The indoor-unit communication filter **208***c* allows high-frequency communication signals transmitted via the second communication line **520** to pass therethrough while preventing DC power transmitted via the second communication line **520** from passing therethrough. The indoor-unit communication filter **208***c* may include a high-pass filter to allow high-frequency signals to pass therethrough while preventing low-frequency signals from passing therethrough.

The indoor-unit power supply **209** includes an indoor unit power supply module **209***a* to supply electric power to the indoor unit **200** and remote controller **400**, an indoor-unit current sensing module **209***b* to sense whether over-current is supplied from the indoor-unit power supply **209** via the second communication line **520**, and an indoor-unit power filter **209***c* to block high-frequency communication signals received via the second communication line **520**. Since the second communication line **520** transmits DC power and high-frequency communication signals, the indoor-unit power filter **209***c* allows DC power transmitted via the second communication line **520** to pass therethrough while preventing high-frequency communication signals transmitted via the second communication line **520** from passing therethrough. The indoor-unit communication filter **209***c* may include a low-pass filter to allow low-frequency signals to pass therethrough while preventing high-frequency signals from passing therethrough.

The indoor-unit control unit **201** may control operation of each element included in the indoor unit **200**. For example, when the temperature detector **204** detects that the indoor temperature is higher than a target cooling temperature, the indoor-unit control unit **201** controls the indoor-unit communication unit **208**, to transmit a cooling request signal to the outdoor unit **100**. The indoor-unit control unit **201** controls the indoor-unit display **203**, to display that the air conditioner **1** is executing a cooling operation. The indoor-unit control unit **201** may include a single general processor to execute arithmetic operations associated with operation of the indoor unit **200**, or a processor to execute specialized arithmetic operations, for example, a communication process to only execute arithmetic operations associated with communications, or a control processor to only execute arithmetic operations associated with control operations.

FIG. **6** illustrates exemplary flows of control signals in the distributer included in the air conditioner according to an embodiment.

Referring to FIG. **6**, the distributer **300** includes a distributer manipulator **302** to receive operation commands associated with the distributer **300** from the user or operator, a distributer display **303** to display operation information of the distributer **300**, and a distributer driver **306** to drive the cooling valve **310** and heating valve **320** included in the distributer **300**. The distributer **300** also includes a distributer storage unit **307** to store programs and data associated with operation of the distributer **300**, a distributer communication unit **308** to communicate with the indoor units **200** and distributer **300** included in the air conditioner **1**, a distributer power supply **309** to supply electric power to the included elements of the distributer **300**, and a distributer control unit **301** to control operation of each included element of the distributer **300**.

The distributer manipulator **302** may include button switches, membrane switches, or a touch panel to receive operation commands associated with the distributer **300**, for example, a power input command. The distributer display **303** may include an LCD panel or an LED panel to display operation information of the distributer **300** such as a connection status of the distributer **300**.

The distributer manipulator **302** or distributer display **303** may be omitted from the distributer **300**.

The distributer driver **306** drives the cooling valve **310** and heating valve **320** in accordance with control signals from the distributer control unit **301**. The distributer driver **306** generates drive current, and supplies the drive current to the cooling valve **310** and heating valve **320** in order to open or close the cooling valve **310** and heating valve **320**.

The distributer storage unit **307** may include a non-volatile memory (not shown) such as a magnetic disc or a solid state drive to permanently store programs and data associated with operation of the distributer **300**. Alternatively, the distributer storage unit **307** may include a volatile memory (not shown) such as a D-RAM or an S-RAM to temporarily store temporary data produced during operation of the distributer **300**.

The distributer communication unit **308** may include a communication module (not shown) to execute communication with the indoor units **200** and distributer **300**, using a communication system such as RS-485.

The distributer power supply **309** may include a rectifying circuit (not shown) to rectify external electric power, and a smoothing circuit (not shown) to remove ripples from the rectified electric power.

The distributer control unit **301** controls operation of each included element included in the distributer **300**. For example, when the distributer control unit **301** receives a request to open the third cooling valve **310-3** (see, for example, FIG. **2**) from the outdoor unit **100** via the distributer communication unit **308**, the distributer control unit **301** controls the distributer communication unit **308**, to transmit a valve opening request reception signal to the outdoor unit **100**. The distributer control unit **301** also controls the distributer driver **306**, to open the third cooling valve **310-3** (FIG. **2**).

FIG. **7**A illustrates exemplary flows of control signals in the remote controller included in the air conditioner according to an embodiment. FIG. **7**B illustrates exemplary a remote-controller power supply and a remote-controller communication unit, which are included in the air conditioner according to an embodiment.

Referring to FIGS. **7**A and **7**B, the remote controller **400** includes a remote-controller manipulator **402** to receive operation commands associated with the indoor units **200** from the user, a remote-controller display **403** to display operation information of the indoor units **200**, and a remote-controller storage unit **407** to store programs and data associated with operation of the remote controller **400**. The remote controller **400** includes a remote-controller communication unit **408** to communicate with the indoor units **200** and another remote controller, a remote-controller power supply **409** to supply electric power to the included elements of the remote controller **400**, and a remote-controller control unit **401** to control operation of each included element of the remote controller **400**.

The indoor-unit manipulator **402** may include button switches, membrane switches, or a touch panel to receive operation commands associated with the indoor units **200**. The remote-controller display **403** may include an LCD panel or an LED panel to display operation information of the indoor units **200**.

The remote-controller storage unit **407** may include a non-volatile memory (not shown) such as a magnetic disc or a solid state drive to permanently store programs and data associated with operation of the remote controller **400**. Alternatively, the remote-controller storage unit **407** may include a volatile memory (not shown) such as a D-RAM or an S-RAM to temporarily store temporary data produced during operation of the remote controller **400**.

The remote-controller communication unit **408** may include a remote-controller communication module **408***a* to execute communication with the indoor units **200** via the second communication line **520**, and a remote-controller communication filter **408***b* to allow high-frequency communication signals received via the second communication line **520** to pass therethrough while preventing DC power received via the second communication line **520** from passing therethrough. The second communication line **520** transmits DC power and high-frequency communication signals. The remote-controller communication filter **408***b* allows high-frequency communication signals transmitted via the second communication line **520** to pass therethrough while preventing DC power transmitted via the second communication line **520** from passing therethrough. The remote-controller communication filter **408***b* may include a high-pass filter to allow high-frequency signals to pass therethrough while preventing low-frequency signals from passing therethrough.

The remote-controller power supply **409** includes a remote-controller power supply module **409***a* to supply electric power to the remote controller **400**, a remote-controller voltage sensing module **409***b* to sense a voltage supplied to the remote-controller power supply **409** via the second communication line **520**, and a remote-controller power filter **409***c* to block high-frequency communication signals received via the second communication line **520**. Since the second communication line **520** transmits DC power and high-frequency communication signals, the remote-controller power filter **409***c* allows DC power transmitted via the second communication line **520** to pass therethrough while preventing high-frequency communication signals transmitted via the second communication line **520** from passing therethrough. In this regard, the remote-controller communication filter **409***c* may include a low-pass filter to allow low-frequency signals to pass therethrough while preventing high-frequency signals from passing therethrough.

The remote-controller control unit **401** may control operation of each element included in the remote controller **400**. For example, when the user changes a target temperature by manipulating the remote-controller manipulator **402**, the remote-controller control unit **401** controls the remote-controller display **403** to display the changed target temperature, and controls the remote-controller communication unit **408** to transmit information of the changed target temperature to the indoor units **200**. The remote-controller control unit **401** may include a single general processor to execute all arithmetic operations associated with operation of the remote controller **400**, or a processor to execute specialized arithmetic operations, for example, a communication process to only execute arithmetic operations associated with communications, or a control processor to only execute arithmetic operations associated with control operations.

Exemplary configurations of the air conditioner associated with flow of refrigerant and flows of signals are disclosed.

An exemplary supply of electric power to the remote controller by one of the indoor units is disclosed.

As described with reference to FIG. **3**, the remote controller **400** does not directly receive electric power from an external power source, but receives electric power from one of the indoor units **200** via the second communication line **520**. The indoor units **200** may be spatially spaced apart from one another by a considerable distance. For example, when one indoor unit **200** is disposed on each floor in a 10-story building with each floor being approximately 2.5 m in height, there is a distance of at least approximately 25 m between the 10th indoor unit **200-10** disposed at the 10th story and the first indoor unit **200-1** disposed at the first story. In this case, when the remote controller **400** is disposed at the first story together with the first indoor unit **200-1**, and the 10th indoor unit **200-10** disposed at the 10th story supplies electric power to the remote controller **400**, the electric power supplied from the 10th indoor unit **200-10** at the 10th story may exhibit voltage drop while reaching the remote controller **400** at the first story, due to parasitic resistance generated in the second communication line **520**. As a result, it may be difficult to supply sufficient voltage to the remote controller **400**.

According to an exemplary embodiment the air conditioner **1** may be controlled to select the indoor unit, which is capable of supplying electric power with sufficient voltage to the remote controller **400**, in order to prevent the remote controller **400** from receiving electric power with insufficient voltage.

FIGS. **8**A and **8**B are flowcharts illustrating an exemplary method for controlling the air conditioner according to an embodiment to automatically select one indoor unit to supply electric power to the remote controller. FIGS. **9**A to **9**C are views illustrating an exemplary procedure of controlling the air conditioner according to an embodiment to select one indoor unit to supply electric power to the remote controller.

Referring to FIG. **3**, FIGS. **8**A and **8**B, and FIGS. **9**A to **9**C, when electric power is applied, e.g., initially applied to the air conditioner **1**, the air conditioner **1** assigns addresses for communications to respective indoor units **200** (**605**). When electric power is initially applied, the outdoor unit **100** searches the first communication line **510** for the indoor units **200** and distributer **300**, and assigns addresses for communications through the first communication line **510** to the outdoor unit **100** itself and the searched indoor units **200** and distributer **300**. For example, when it is assumed that the air conditioner **1** includes 10 indoor units, as illustrated in FIG. **9**A, the outdoor unit **100** may assign addresses to the outdoor unit **100**, indoor units **200**, and distributer **300** included in the air conditioner **1** in such a manner that an address "001" is assigned to the outdoor unit **100**, an address "002" is assigned to the distributer **300**, an address "003" is assigned to the first indoor unit **200-1**, an address "004" is assigned to the second indoor unit **200-2**, and an address "012" is assigned to the last indoor unit, namely, the 10th indoor unit **200-10**.

The air conditioner **1** selects, from among the indoor units **200**, one indoor unit to supply electric power to the remote controller **400**, namely, the power-supplying indoor unit PM (**610**). For example, the air conditioner **1** may select the power-supplying indoor unit PM, based on the addresses assigned to the indoor units **200** by the outdoor unit **100**. That is, the air conditioner **1** may select the first indoor unit **200-1** assigned a lowest one of the addresses assigned to the indoor units **200**, namely, the address "003", as an initial power-supplying indoor unit PM.

The air conditioner **1** determines whether one indoor unit other than the power-supplying indoor unit PM supplies electric power to the remote controller **400** (**615**). When the power-supplying indoor unit PM and another indoor unit are connected to the second communication line **520** at opposite polarities, for example, when the power supply terminal of the power-supplying indoor unit PM and the ground terminal of the other indoor unit are connected to the first communication wire of the second communication line, and the ground terminal of the power-supplying indoor unit PM and the power supply terminal of the other indoor unit are connected to the second communication wire of the second communication line, and electric power is supplied through the second communication line by the other indoor unit and the power-supplying indoor unit PM, the power-supplying indoor unit PM and the other indoor unit are short-circuited. The power-supplying indoor unit PM and the other indoor unit may be damaged. When the indoor-unit current sensing module **209***b* (see, for example, FIG. **5**B) of the power-supplying indoor unit PM senses current under the condition that the indoor-unit power supply module **209***a* (see, for example, FIG. **5**B) of the power-supplying indoor unit PM does not supply electric power to the remote controller **400**, the air conditioner **1** may determine that the other indoor unit supplies electric power to the remote controller **400** via the second communication line **520**.

When it is determined that the other indoor unit does not supply electric power to the remote controller **400** ("NO" in operation **615**), the air conditioner **1** determines whether over-current is sensed in the power-supplying indoor unit PM when the power-supplying indoor unit PM supplies electric power to the remote controller (**620**). When the power-supplying indoor unit PM supplies electric power to the remote controller **400** for a short time, and the magnitude of the current sensed by the indoor-unit current sensing module **209***b* (FIG. **5**B) of the power-supplying indoor unit PM is equal to or higher than a reference current magnitude, the air conditioner **1** may determine that over-current has been generated.

When it is determined that over-current has not been generated ("NO" in operation **620**), the air conditioner **1** controls the power-supplying indoor unit PM to supply electric power to the remote controller **400** (**625**). The indoor-unit power supply module **209***a* (see, for example, FIG. **5**B) supplies electric power to the remote controller **400** via the second communication line **520**.

The air conditioner **1** detects a voltage supplied to the remote controller **400**. In detail, when electric power is supplied via the second communication line **520**, the remote-controller voltage sensing module **409***b* (FIG. **7**B) of the remote controller **400** may sense a voltage value of the electric power supplied to the remote controller **400**.

The air conditioner **1** stores the sensed voltage value in a supply voltage table VT (**640**). The remote controller **400** transmits the voltage value sensed by the remote-controller voltage sensing module **409***b* (FIG. **7**B) to the power-supplying indoor unit PM via the second communication line **520**. The power-supplying indoor unit PM may store the address of the power-supplying indoor unit PM and the voltage value transmitted thereto in the supply voltage table VT as shown in FIG. **9**D.

When one indoor unit other than the power-supplying indoor unit PM supplies electric power to the remote controller **400** ("YES" in operation **615**), or when over-current is sensed ("YES" in operation **620**), the air conditioner **1** stores an error in the supply-voltage table VT (**645**). That is, when another indoor unit other than the power-supplying indoor unit PM supplies electric power via the second communication line **520**, or when over-current is sensed during power supply of the power-supplying indoor unit PM, the power-supplying indoor unit PM stores an error in the supply-voltage table VT without supplying electric power via the second communication line **520**.

When a voltage value of electric power or an error is stored in the supply-voltage table VT, the air conditioner **1** determines whether the current power-supplying indoor unit PM is a final one of the indoor units (**650**). When the number of voltage values stored in the supply voltage table VT or the number of errors stored in the power supply table VT is identical to the number of the indoor units **200**, or when the address of the current power-supplying indoor unit PM corresponds to a final one of the addresses assigned to the indoor units, namely, the address "012", the air conditioner **1** may determined that the current power-supplying indoor unit PM is the final indoor unit.

When the current power-supplying indoor unit PM is not the final indoor unit ("NO" in operation **650**), the air conditioner **1** selects another indoor unit as the power-supplying indoor unit PM (**655**). The air conditioner **1** may designate, as a new power-supplying indoor unit, another indoor unit, which is assigned a next one of the addresses assigned by the outdoor unit **100**. When a new power-supplying indoor unit is designated, the previous power-supplying indoor unit may transmit a supply voltage table VT to the new power-supplying indoor unit.

The air conditioner **1** repeats procedures of determining whether another indoor unit as a news power-supplying indoor unit PM supplies electric power, determining whether over-current is sensed, and supplying electric power via the second communication line **520**, until the final indoor unit supplies electric power.

When the power-supplying indoor unit PM is the final indoor unit ("YES" in operation **650**), the air conditioner **1** selects the power-supplying indoor unit PM, based on the supply voltage table VT (**665**). The air conditioner **1** selects, as the power-supplying indoor unit PM, the indoor unit, which supplies a highest one of the voltage values written in the supply voltage table VT. For example, when data as illustrated in FIG. **9**D is stored in the supply voltage table VT, the air conditioner **1** may select the first indoor unit **200-1** assigned an address "003" as the final power-supplying indoor unit PM.

When there are two or more remote controllers, it may be possible to select, as the power-supplying indoor unit PM, the indoor unit, which exhibits a highest arithmetic average of voltage values transmitted by the remote controllers or a highest root mean square of the voltage values transmitted by the remote controllers.

The air conditioner **1** controls the indoor unit finally selected as the power-supplying indoor unit PM to supply electric power to the remote controller **400** (**670**). In other words, the indoor unit **200**, which supplies a highest voltage, among the indoor units **200**, supplies electric power to the remote controller **400**.

A method of automatically selecting the power-supplying indoor unit PM to supply electric power to the remote controller **400** has been described. However, the air conditioner **1** may not automatically select the power-supplying indoor unit PM due to errors, e.g., unexpected errors. For example, when electrical power is constantly supplied via the second communication line **520** due to malfunction of two or more indoor units, the supply voltage table VT has completely been stored with errors. In this case, the air conditioner **1** may not automatically select the power-supplying indoor unit PM.

A user may select the power-supplying indoor unit PM.

FIG. **10** is a flowchart illustrating an exemplary method for controlling the air conditioner to select one indoor unit to supply electric power to the remote controller in accordance with a user's selection.

Referring to FIGS. **3** and **10**, when electric power is assigned, e.g., initially applied to the air conditioner **1**, the air conditioner **1** assigns addresses for communications to respective indoor units **200** (**705**). When electric power is initially applied, the outdoor unit **100** searches the first communication line **510** for the indoor units **200** and distributer **300**, and then assigns addresses for communications through the first communication line **510** to the outdoor unit **100** itself and the searched indoor units **200** and distributer **300**.

The air conditioner **1** selects, from among the indoor units **200**, one indoor unit to supply electric power to the remote controller **400**, namely, the power-supplying indoor unit PM, in accordance with a user's selection (**710**). For example, the user may select one of the indoor units **200** as the power-supplying indoor unit PM by manipulating the outdoor unit **100**.

The air conditioner **1** determines whether one indoor unit other than the power-supplying indoor unit PM supplies electric power to the remote controller **400** (**715**). In detail, when the indoor-unit current sensing module **209**b (see, for example, FIG. **5**B) of the power-supplying indoor unit PM senses current under the condition that the indoor-unit power supply module **209**a (FIG. **5**B) of the power-supplying indoor unit PM does not supply electric power to the remote controller **400**, the air conditioner **1** may determined that the other indoor unit supplies electric power to the remote controller **400** via the second communication line **520**.

When it is determined that the other indoor unit does not supply electric power to the remote controller **400** ("NO" in operation **715**), the air conditioner **1** determines whether over-current is sensed in the power-supplying indoor unit PM when the power-supplying indoor unit PM supplies electric power to the remote controller (**720**). When the power-supplying indoor unit PM supplies electric power to the remote controller **400** for a short time, and the magnitude of the current sensed by the indoor-unit current sensing module **209**b (FIG. **5**B) of the power-supplying indoor unit PM is equal to or higher than a reference current magnitude, the air conditioner **1** may determine that over-current has been generated.

When it is determined that over-current has not been generated ("NO" in operation **720**), the air conditioner **1** controls the indoor unit selected as the power-supplying indoor unit PM by the user to supply electric power to the remote controller **400** (**725**). In order words, the indoor unit selected by the user from among the indoor units **200** supplies electric power to the remote controller **400**.

When one indoor unit other than the power-supplying indoor unit PM supplies electric power to the remote controller **400** ("YES" in operation **715**), or when over-current is sensed ("YES" in operation **720**), the air conditioner **1** displays a condition that it is impossible to supply electric power to the remote controller **400**, to inform the user of the condition (**730**). For example, the outdoor unit **100** may display erroneous setting of the power-supplying indoor unit through the outdoor-unit display **103** (FIG. **4**) while displaying a recommendation to select another indoor unit as the power-supplying indoor unit PM.

In accordance with an aspect of the present invention, it may be possible to supply electric power with a sufficiently high voltage to a remote controller by supplying electric power to the remote controller by one indoor unit exhibiting a highest voltage value of electric power to be supplied to the remote controller, as compared to other indoor units.

Although a few embodiments of the present invention have been shown and described, it would be appreciated by those skilled in the art that changes may be made in these embodiments without departing from the principles and spirit of the invention, the scope of which is defined in the claims and their equivalents.

What is claimed is:

1. An air conditioner comprising:

at least one outdoor unit configured to execute a heat exchange operation for a heat exchange between outdoor air and a refrigerant;

a plurality of indoor units configured to a execute heat exchange operation for the heat exchange between indoor air and the refrigerant; and

at least one remote controller configured to receive a user input for the plurality of indoor units and communicate with the plurality of indoor units through a communication line, wherein at least one indoor unit among the plurality of indoor units is selected based on voltage values of electric power supplied to the at least one remote controller from the plurality of indoor units, and

the at least one remote controller is supplied with the electric power from the at least one indoor unit through the communication line.

2. The air conditioner according to claim 1, wherein DC electric power is supplied from the at least one indoor unit to the at least one remote controller through the communication line while high-frequency communication signals being transmitted through the communication line.

3. The air conditioner according to claim 2, wherein the at least one remote controller comprises a remote-controller power supply module to receive the DC power supplied from the at least one indoor unit via the communication line, and a remote-controller power filter to block the high-frequency communication signals.

4. The air conditioner according to claim 2, wherein each of the plurality of indoor units comprises an indoor-unit power supply module to supply the DC power to the at least one remote controller via the communication line, and an indoor-unit power filter to block the high-frequency communication signals.

5. The air conditioner according to claim 1, wherein, when the plurality of indoor units supply electric power to the at least one remote controller in accordance with a predetermined sequence, the at least one remote controller detects voltage values of the electric power supplied from the plurality of indoor units.

6. The air conditioner according to claim 5, wherein the plurality of indoor units supply electric power to the at least one remote controller in accordance with a predetermined sequence based on addresses of the plurality of indoor units.

7. The air conditioner according to claim 5, wherein each of the plurality of indoor units determines whether another one of the plurality of indoor unit supplies electric power to the at least one remote controller, and supplies electric power to the at least one remote controller when it is determined that there is no indoor unit supplying electric power to the at least one remote controller.

8. The air conditioner according to claim 5, wherein each of the plurality of indoor units determines whether over-current flows through the communication line, and supplies electric power to the at least one remote controller when it is determined that no over-current flows through the communication line.

9. The air conditioner according to claim 5, wherein the at least one indoor unit is selected from among the plurality of indoor units, based on the voltage values detected by the at least one remote controller.

10. The air conditioner according to claim 9, wherein, when the at least one remote controller comprises a single remote controller, the at least one indoor unit, which supplies electric power with a highest voltage value detected by the single remote controller, is selected from among the plurality of indoor units.

11. The air conditioner according to claim 9, wherein, when the at least one remote controller comprises at least two remote controllers, the at least one indoor unit, which supplies electric power with a highest average of voltage values detected by the at least two remote controllers, is selected from among the plurality of indoor units.

12. A method for controlling an air conditioner including at least one outdoor unit, a plurality of indoor units, and at least one remote controller, comprising:

measuring voltage values of electric power supplied from the plural indoor units;

selecting at least one indoor unit among the plurality of indoor units based on the measured voltage values; and

supplying electric power to the at least one remote controller from the at least one indoor unit via a communication line, through which the plurality of indoor units and the at least one remote controller communicate each other.

13. The method according to claim 12, wherein DC electric power is supplied from the at least one indoor unit to the at least one remote controller through the communication line while high-frequency communication signals being transmitted through the communication line.

14. The method according to claim 12, further comprising supplying the electric power to the at least one remote controller from the plurality of indoor units in accordance with a predetermined sequence based on addresses of the plurality of indoor units.

15. The method according to claim 14, further comprising determining whether one of the plurality of indoor units supplies electric power to the at least one remote controller, and supplying electric power to the at least one remote controller when it is determined that there is no indoor unit supplying electric power to the at least one remote controller.

16. The method according to claim 14, further comprising determining whether over-current flows through the communication line, and supplying electric power to the at least one remote controller when it is determined that no over-current flows through the communication line.

17. The method according to claim 12, wherein, when the at least one remote controller comprises a single remote controller, the selecting of the at least one indoor unit comprises selecting the at least one indoor unit, which supplies electric power with a highest voltage value detected by the single remote controller, as the power-supplying indoor unit.

18. The method according to claim 12, wherein, when the at least one remote controller comprises at least two remote controllers, the selecting of the at least one indoor unit comprises selecting the at least one indoor unit, which supplies electric power with a highest average of voltage values detected by the at least two remote controllers, as the power-supplying indoor unit.

19. A method for controlling a device including at least one unit in a first location, a plurality of units in a second location, and at least one remote controller, comprising:

supplying power to the at least one remote controller from at least some of the plurality of units in the second location;

detecting a voltage value of the power respectively supplied from the at least some of each of the plurality of units in the second location;

selecting a power-supplying unit in the second location to supply power to the at least one remote controller, based on the detected voltage values; and

supplying the power to at least one remote controller from the selected power-supplying unit via a communication line, through which the plurality of indoor units and the at least one remote controller communicate each other.

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